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Adaptive Capacities, Path Creation and Variants of Sectoral Change

The Case of the Transformation of the German Energy Supply System

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Abstract

Since the proclamation of the German 'Energiewende' by the Federal Government in 2011, the transition of the energy supply system has accelerated. In 2011, the "Helmholtz-Alliance" — "ENERGY TRANS – Future Infrastructures for Meeting Energy Demands. Towards Sustainability and Social Compatibility" — was launched to perform an interdisciplinary analysis of the social challenges presented by the energy transition. The study presented here, "Adaptive Capacities, Path Creation, and Variants of Sectoral Change" is embedded within the "Helmholtz-Alliance" and analyses the organizational changes within the German energy system from a sociological perspective.

The study applies the "Theory of Strategic Action Fields" by Neil Fligstein and Doug McAdam – an actor-centred approach focusing on the change of organizational fields. The study is divided into four projects. Project one, "The Role of the Leading German Energy Providers in the Transformation of the German Energy System", and project two, "The Integration of Volatile Renewable Energies into the German Electricity System — The Role of the Established Power Industry for the Extension of Electricity Grids — A Comparative Case Study", focus on the established players in the German energy system – the big energy-provider companies. Project three, "Challenging the Established Consensus? Local/Regional Initiatives and the Transformation of the Energy Sector", examines challengers acting at a decentralized level. The thematic framework of the projects requires a qualitative research design and applies the methods of document analysis, expert interviews, and focus groups.

A fourth project, "Patterns and Variants of the Gradual Socio-Technical Transformation of the Energy Sector", integrates the results of projects one to three and reports on the overall changes in the German energy supply system. This integration of results applies Ulrich Dolata's theory on the transformation of socio-technical sectors.

This study not only brings together empirical information on the progress of energy transitions, but also contributes to the theoretical discourse within the social sciences by empirically testing theories that so far have not yet been sufficiently examined.

Zusammenfassung

Die Liberalisierung der Energiemärkte, die sukzessive Zunahme des Anteils regenerativer Energien am Strommix und das Auftreten neuer Marktakteure verändern das deutsche Stromversorgungssystem. Nach dem Atomunfall in Fukushima von 2011 hat die Bundesregierung beschlossen, aus der Atomkraft auszusteigen. Gleichzeitig rief sie die „Energiewende" aus und kündigte an, den Wechsel zu erneuerbaren Energien zu beschleunigen. Die im selben Jahr ins Leben gerufene „Helmholtz-Allianz" „ENERGY TRANS – Zukünftige Infrastrukturen der Energieversorgung. Auf dem Weg zur Nachhaltigkeit und Sozialverträglichkeit" untersucht in interdisziplinärer Zusammenarbeit die gesellschaftlichen Herausforderungen der Energiewende. Das hier vorgestellte Projekt „Adaptive Capacities, Path Creation and Variants of Sectoral Change" ist in diese Forschungsallianz eingebunden und untersucht aus organisationssoziologischer Perspektive den Wandel des deutschen Energiesystems.

Als theoretisches Fundament der Untersuchung ist eine akteurzentrierte Theorie mit Fokus auf dem Wandel von organisationalen Feldern – die „Theorie der Strategischen Handlungsfelder" von Neil Fligstein und Doug McAdam – besonders geeignet. Dabei unterteilt sich das Projekt in vier Subprojekte: Projekt eins „The Role of the Leading German Energy Providers in the Transformation of the German Energy System" und Projekt zwei „The Integration of Volatile Renewable Energies into the German Electricity System – The Role of the Established Power Industry for the Extension of Electricity Grids – A Comparative Case Study" legen den Fokus auf die etablierten Akteure des deutschen Energiesystems – die großen Stromkonzerne – während Projekt drei „Challenging the Established Consensus? Local/Regional Initiatives and the Transformation of the Energy Sector" die Herausforderer auf dezentraler Ebene in den Blick nimmt. Der thematische Rahmen der Projekte erfordert eine qualitative Herangehensweise – es kommen die Methoden der Dokumentenanalyse, des Experteninterviews sowie der Fokusgruppe zum Einsatz.

In einem vierten Projekt „Patterns and Variants of the Gradual Socio-Technical Transformation of the Energy Sector" werden die Ergebnisse der drei genannten Subprojekte zusammengeführt und es entsteht ein plastisches Bild der Veränderungen im deutschen Energieversorgungsystem. Den theoretischen Rahmen für diese abschließende Integration der Ergebnisse bildet die Theorie zum Wandel soziotechnischer Sektoren von Ulrich Dolata. Die einzelnen Projekte sammeln nicht nur empirische Informationen über den Verlauf der Energiewende, sie leisten auch ein Beitrag zum sozialwissenschaftlichen Theorie-Diskurs, indem die angewandten, bislang nur selektiv getesteten Theorien einer empirischen Prüfung ausgesetzt werden.

Contents

1 Introduction: 'Energiewende' — Energy Transition: A Challenge for the Field of Energy Supply[1]

The fatal nuclear accident at Fukushima had far-reaching consequences for the German energy system. The government revised its previous decision to postpone the phase out nuclear power as an energy source and in March 2011 it stopped the operation of eight nuclear reactors. On 30 June 2011, the Bundestag, with a big majority, decided in favor of shutting down Germany's final nuclear plant by 2022. Chancellor *Angela Merkel* issued a clear statement in favor of this transition. She declared that the events in Fukushima were a turning point for her personally. Even in a high-tech country like Japan, the risks posed by nuclear power could not be fully controlled. "Fukushima has changed my attitude to nuclear power", she said[2] and "renewable energy should become the central pillar of our future energy supply"[3].

1.1 The Helmholtz-Association — The Organizational Embedding of the Project

In this context the Helmholtz-Association (*www.helmholtz.de/en/*), Germany's largest research organization, started a new research alliance "Future Infrastructures for meeting energy demands. Requirements of sustainability and social compatibility". The consortium, which consists of three Helmholtz centers, three universities, and the European Centre For Economic Research (Mannheim), is running 17 projects, organized under five themes (see Table one), to investigate problems related to the so-called *Energiewende*.

To shut down nuclear reactors and at the same time achieve ambitious targets for carbon reductions, requires innovative action by politicians, economic actors, and citizens. The research projects within the alliance's framework intend to analyze the conditions that are required to actually realize the *Energiewende*, the preconditions that have to be met in order to achieve a successful and sustainable transition, and the unintended consequences that might occur. The researchers come from a variety of scientific disciplines and include engineers, physicists, lawyers, economists, psychologists, philosophers, political scientists, and sociologists among others. Project B 1 (run by the Department for the Sociology of Organization and Innovation Studies at the University of Stuttgart) will attempt to reconstruct and empirically analyze the ongoing transition process in the energy supply sector along the following lines of reasoning: the measured diffusion of new technologies, whose features may still be subject to drastic changes during the course of the transformation process; the suc-

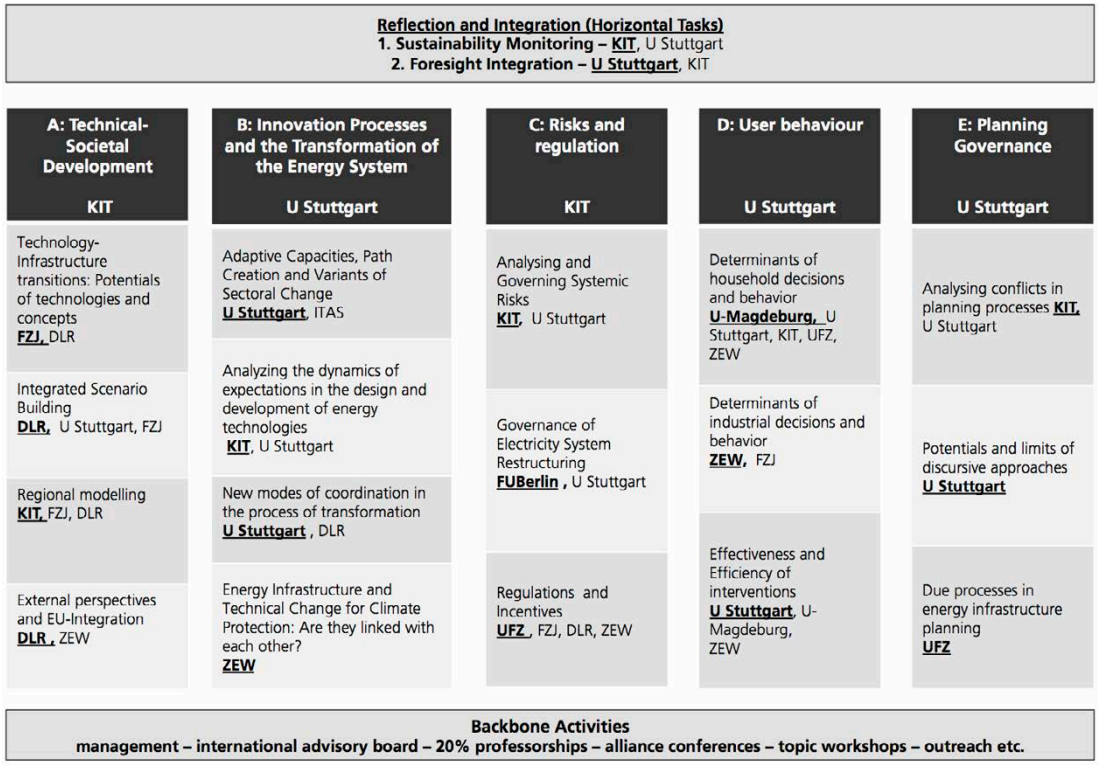
[1] The authors would like to thank Ulrich Dolata and Raymund Werle for their helpful comments to an earlier version of this discussion paper and Leonie Steckermeier for additional work.

[2] http://www.bundesregierung.de/Content/EN/Artikel/_2011/06/2011-06-09-regierungserklaerung_en.html

[3] http://www.reuters.com/article/2011/03/17/us-germany-nuclear-idUSTRE72E3ZO20110317

cessive formation of new markets and non-market relations; patterns of competition and cooperation; the gradual modernization of structures and institutional arrangements within the investigated field; the accompanying changes among incumbent actor configurations; and relations of power and influence.

Table 1: The Projects within the Helmholtz Alliance "Future Infrastructures for Meeting Energy Demands. Requirements of Sustainability and Social Compatibility"



Source: http://www.helmholtz.de/en/

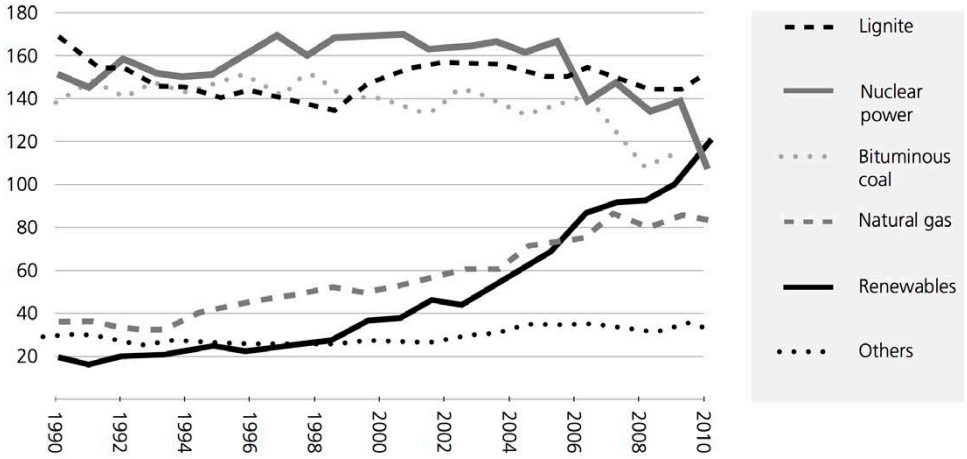
The discussions on Germany's energy transition have to be seen in the context of an increasing awareness about the importance of energy infrastructures and the way energy is provided. The energy supply system is a critical infrastructural element; every sector within our society — whether transport and mobility, housing, food production and healthcare — depends on a reliable and affordable system of energy supply. On the other hand, the energy supply system has come under attack for its negative environmental impact and especially its effect on climate change. For several decades now there have been attempts to change the system of energy supply and consumption. Despite these many efforts and the multitude of resources spent aiming at reducing energy consumption, diversifying energy sources, and developing alternative energy technologies, the system is still highly dependent on fossil fuels. In view of the importance of a stable and secure energy provision system, an analysis of the mechanisms that can bring about transformative results is paramount. Equally important is an on-going evaluation of the changes observed from the perspective of

socially desirable outcomes. The envisaged five-year time frame for the Helmholtz Alliance projects offers an unusually apt opportunity to analyse on-going change processes in detail. Many contributions and analyses already exist from social scientific and innovation research. These can be used for our analysis, but they also require refinement for the task envisioned. Based on recent thinking by Dolata (2011a), a transformation-oriented perspective will be applied and developed further.

1.2 The Current State of the German Energy Supply System

The European Commission has stated that "the energy challenge is one of the greatest tests our society has to face. It will take decades to steer our energy systems onto a more secure and sustainable path." (European Commission 2010) Indeed, the system has proved to be hard to change. Reasons for this inertia can be seen in the energy system's path dependent development, seemingly locked onto a fossil-fuel path, which finds expression in the characteristics and aims of the incumbent actors of the field. While some experts and organizations have repeatedly argued that we need to implement a radical shift toward full scale renewable energy supply, others argue that we can sustain fossil fuel production if, for example, we successfully implement Carbon Capture and Storage (CCS). And there are those who claim that the diffusion of renewable energies will involve too slow a process that will be unable to meet energy demand, implying a need to invest in so-called bridge technologies such as nuclear power or gas before switching to a fully sustainable system of energy supply. And there are even those who — because of a supposedly new "gas revolution" — fundamentally question the relevance of renewable energies. These different pathways, proposed by highly heterogeneous groups and backed by different interests and lobby groups, are in principle, mutually exclusive.

Fig. 1: Gross Electricity Production in Germany in bn kWh.



Data: AG Energiebilanzen e.V. 2012

Nevertheless, a slow but steadily progressing increase of renewable energies in the energy supply mix can be observed (see Figure one). But since Fukushima — in face of new developments concerning nuclear power and the broad parliamentary support for the *Energiewende* — the pressure on the traditional structures of the energy supply system has been growing to accommodate even more far-reaching changes.

During the 1990s, the aim of large energy companies and their partners in politics and science was to prevent the diffusion of renewable energy technologies, especially wind power and photovoltaics. Energy providers therefore at first strongly opposed the Electricity Feed-In Act, which became the main legislative basis for operating renewable power devices in Germany and for ensuring grid access to energy produced by external actors such as farmers, local producer groups, and smaller ecological investment funds which had entered the field of energy provision. For several years the central producer association, VDEW, launched judicial attacks against the Electricity Feed-In Act at different court levels right up to the European Court of Justice, who finally refused to accommodate their complaints in 2002 (Tacke 2004). The energy companies had therefore failed to prevent wind power and photovoltaics from achieving the status of stable components in the electricity market. Although they have stopped open resistance, they still try to hinder or even prevent the switch to renewable energies — but in more subtle and careful ways. For example, they claim that renewables are too expensive, that nu-clear power would be more secure, and (even more carefully) that climate change is not an outcome of CO2 and methane emissions (e.g. Lüning/Vahrenholt 2012). At the same time they advocate longer operating times for their nuclear plants and also support the development of Carbon Capture and Storage (CCS) to extend the service lives of newly built coal fired power plants. Investment by the major energy providers in the development of renewable energy capacities has been negligible apart from a few exceptions and the public announcements to build large offshore wind parks and solar thermal power plants in Southern countries (especially in Northern Africa).

1.3 Overview

In the present paper we introduce the analytical steps taken by the research group at the Department of Sociology of Organization and Innovation Studies to analyse transition processes in the energy supply system. Energy in this context mainly refers to electricity. The paper is organized as follows: Chapter 2 presents the theoretical framework adopted for the study. Chapters 3 to 5 present three projects that will be dealt with over the next three of the five years that the Alliance is expected to run. It is important to stress at this point that rather than aiming at a comprehensive analysis of the transition processes, this study examines its highly contentious issues. The list of issues is not yet final and will extend over the project's five year period.

2 The Energy Sector as a Strategic Action Field: Between Stability and Transformation

The energy system is a prime example of a large technical system (Mayntz/Hughes 1988, Mayntz 2009) characterized by a substantial degree of institutional inertia. To adapt to new demands from public authorities and consumers, the energy sector needs to show a significant degree of flexibility. The more intensive the organizational needs, and the more complex and empowered a socio-technical system's structures are, the more demanding and protracted a substantial transformation will be. This is especially true for the tightly knit networks and the capital-intensive organization that exist in the energy supply system.

The projects that we introduce in the following, analyse and highlight different aspects of the process of sectoral change and discuss whether there are indicators for a more substantial on-going transformation of the sector. Before discussing the individual projects it is important to clarify the overall analytical framework that tie them together.

2.1 State of the Art

For our analytical purposes we could have used more classical institutionalist approaches (sectoral innovation systems, technological innovation systems) or perspectives that stress a potential system transformation to a more sustainable state of whatever is at stake (transition approaches). However, we have opted for an approach — the theory of strategic action fields as developed by Fligstein/McAdam (2012) — that seems best able to cope with the following very special circumstances:

(a) Our research object concerns not "one" technology and its development, and technological challenges do not constitute the main driving force for the changes in the energy sector;

(b) We are primarily interested in the dynamics of a process and not so much in analyzing more or less stable institutions;

(c) We see the development of the system as open ended and characterized by competing aims and visions.

Since Fligstein and McAdam's theory under conceptualizes the area between incremental and radical change, we also apply recent thinking by Dolata (2011a) on the different variants of socio-technical change. Research so far has developed different analytical approaches to study sectoral transformation. Some of these will be briefly discussed here to help better under-stand the theoretical option we have chosen.

One important line of reasoning can be associated with the so called "transition"-literature. It claims to have an analytical apparatus that would help us both under-stand as well support infrastructure transitions towards a more sustainable state. Research

done in this tradition meanwhile shows an amazing breadth (see Truffer 2012). Nevertheless, it faces some shortcomings. It has an implicit normative character, arguing that transition processes will and have to go in a direction towards more sustainability. We actually see transition processes as being open ended. The outcomes of these processes are the product of a struggle between actors who de-fine sustainability in different ways, and favour different strategies and methods. A cornerstone of the transition approach is its emphasis on niches. Niches are important since they contain the seeds for transition processes. Niches therefore have to be protected, and new technologies have to be experimented within these niches until they are ready to help transform the system. We share the view that transformation or radical change from within a system or sector is unlikely. We doubt, however, whether the niche concept provides the best analytical concept for under-standing transition processes. Niches by themselves do not necessarily transform a sector. Niches are to be found everywhere. There are niche markets which thrive on the simple fact that they concentrate on niches, e.g. by offering very high quality or specialized products or services which are relevant only for a tiny minority. However, radical change in sectors such as telecommunications, was not driven forward by niche actors but by political decisions and powerful actors from outside the field. The niche argument ultimately tends to underrate actors' aspirations and strategies which may or may not aim at sectoral transformation.

Another line of reasoning is represented by the Technological Innovation System approach. Again, this approach has produced an impressive number of valuable studies over recent years and we can benefit from their results (Coenen/Lopez 2010). Pioneering work on TIS was carried out by Bo Carlsson and Rikard Stankiewicz (1991). They define it as: "network(s) of agents interacting in a specific economic/industrial area under a particular institutional infrastructure or set of infrastructures and involved in the generation, diffusion, and utilization of technology. Technological systems are defined in terms of knowledge or competence flows rather than flows of ordinary goods and services. They consist of dynamic knowledge and competence networks." (Carlsson/Stankiewicz 1991: 111). Given that technology is the common denominator in TIS, a framework can be used that is geared to studying how the configuration of actors, networks, and institutions changes over time as the technology develops (Carlsson 1997). Recently, the emphasis on a dynamic analysis of TIS has received considerable impetus by explicitly focusing on the functions, activities, or processes taking place within the system of innovation (Hekkert et al. 2007, Bergek et al. 2008). It remains somewhat ambiguous, however, how exactly the boundaries of a technological domain are set in relation to its geographical and sectoral embeddedness. Markard/Truffer (2008) remain critical of the inconsistent way that empirical studies of TI-systems have de-lineated the system, using it either in a rather descriptive way as a synonym for sector or just as a catchword. From a sociological point of view the use of the systems metaphor and its more or less arbitrary listing of functions and treatment of institutions has been criticized.

Recent theorizing in the social sciences in general has stressed the importance of the meso-level and especially of meso-level social orders where actors (who can be individual or collective) interact with knowledge of one another under a set of common understandings about the purposes of (in our case) a specific sector, a field, the relationships there (including who has power and why), and the sectors' rules (cp. Martin 2011). Observing actions in meso-level social orders has already been implied in the various versions of institutionalist thinking. Meso-level orders have been variously called sectors, organizational fields, games, fields or networks. Most of this theorizing, however, is very static. It is difficult to use the insights produced by these studies to investigate change. Concepts like, for example, "institutional" or "organizational logic" are well suited for analysing periods of stability, but not for the study of processes of (potential) transformation.

Interdisciplinary innovation research, finally, has also stressed the importance of the meso-level for understanding respective processes. For example, a whole series of research has been done under the label of "Sectoral Systems of Innovation" (Malerba 2004). This research, however, also suffers from an under-conceptualization of the processes of change and transformation. In the institutional tradition, processes of transformation are described as "periods of mismatch" (Dosi et al. 1988: 11) or as "periods of considerable confusion" (Henderson/Clark 1990: 12). Thus a more thoroughgoing analysis is necessary that highlights the interplay between incumbent, stabilizing, and changing forces.

2.2 The Theory of Strategic Action Fields

In our view, the theory of strategic action fields provides an analytical framework that enables the analysis of dynamic developments, is not normatively based, and is also not technology centred.

2.2.1 Who and What Can be Drivers of Change?

We conjecture that a strategic action field is dominated by a set of incumbent actors who share a common belief about what the field is all about, how specific positions are attributed to actors, what the aims of the field are, and the legitimate ways to pursue these aims. From a plentiful supply of empirical evidence and theoretical considerations, we can safely assume that incumbent actors will try to oppose demands for change that will destabilize their position in the field and dominant ways of doing things. Change will therefore be driven forward mostly by challenger ac-tors, less powerful actors within the strategic action field under analysis, or from outside actors "invading" the field.

2.2.2 What Are the Mechanisms Producing Change?

External developments that have relevance to internal field processes can include the following: political decisions such as the *Energiewende* or the liberalization of energy markets; changes in macro-cultural discourse such as the growing awareness of the dangers of climate change; or widespread external opposition against specific technological options such as nuclear energy. For significant change to take place, these external developments have to pose significant threats, or provide opportunities for the realization of collective interests. Those delivering the threats or opportunities must have command over sufficient significant resources in order to be able to generate and sustain action. Significant changes to a field will also require the use of innovative and new — possibly previously prohibited — forms of collective action. The role of individual or corporate skilled actors is paramount. They need not only to fight for a new interpretation of what the field is all about, but they will also have to forge new coalitions and compromises reaching beyond the initial set of challenger actors.

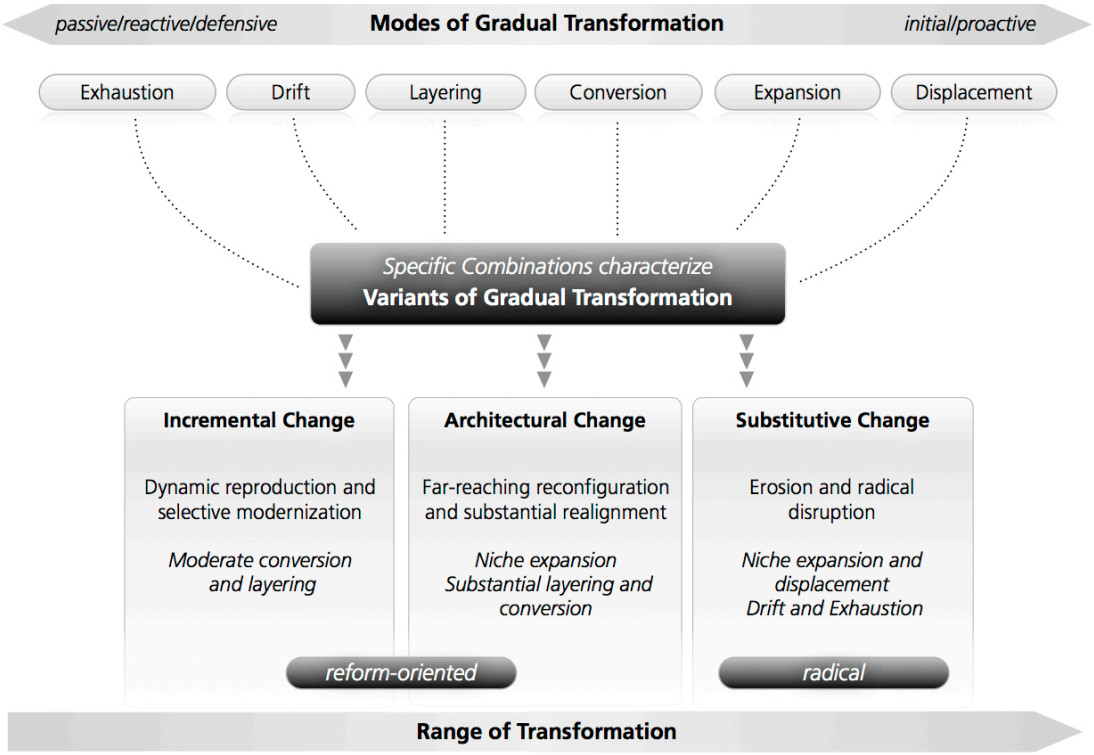
2.2.3 What Are the Processes of Change?

The theoretical explanation Fligstein offers on change in strategic action fields seems to be too dichotomic to integrate the various research efforts done within the scope of the overall study. According to Fligstein/McAdam, change seems to be either incremental or radical. The area in between, however, remains under conceptualized in spite of the fact that Fligstein/McAdam make clear that wholesale transformation processes happen only very seldom. Most change, and especially transformative change over the long term, happens in small steps. We therefore apply at this point Dolata's taxonomy on the different variants of socio-technical transformation. Dolata understands socio-technical change more generally as a gradual transformation — a multi-phased, often erratic and non-linear process of change which may consolidate into substantial sector adjustments. "*Transformation* means: change resulting in the radical realignment of a field, by which both its technical profile and the connected social coordinates are significantly modified. *Gradual*, on the other hand, emphasizes the fundamental procedural peculiarity of such changes, which essentially occur by degrees as an accumulation of numerous transformation-related impulses extending over a longer period of time." (Dolata 2011b: 27)

Specifying this, his taxonomy differentiates between four types of gradual change, which we will briefly outline at this point: (1) *Dynamic Reproduction and Incremental Change*. This variant falls outside of the boundaries of radical socio-technical change since the pressure on the involved organizations to adapt to change is relatively moderate. In the variants (2) *Substantial Realignment and Architectural Change* and (3) *Disruption, Erosion and Substitutive Change* a high pressure for change comes from the fringes of the field or from the field's environment, challeng-

ing — in the first case — relatively adaptive established actors and — in contrast in the second variant — established actors incapable of adapting. In the variant (4) *Enduring Coexistence, Substitutive or Architectural Change* an alternative path evolves parallel to the established path. This mainly applies to fields which are marked by tightly knit networks and capital- and organization-intensive infrastructures (Dolata 2011b: 22ff.). This taxonomy is used to analyze the results of the individual projects and is the basis for discussing pathways of transition. This concept also implies that the ability of organizations to adapt to pressures of change decisively shapes the process of transformation within a given field (Dolata 2011a: 75 ff.).

Fig. 2: Modes and Variants of Gradual Transformation



Source: Dolata 2011b: 21

2.2.4 What Can Be the Eventual Outcomes?

Analyses of processes of sectoral transition have shown that such processes as well as their outcomes are difficult to predict and might take different forms such as: (a) a re-imposition of the old regime with some adjustments; (b) the break down into unorganized social space; (c) the partitioning into several spaces (e.g. renewable vs. traditional energy generation); (d) the development of a wholly new regime (cp. Mahoney/Thelen 2010, Fligstein/McAdam 2011). We reserve the term "transformation" for the last option.

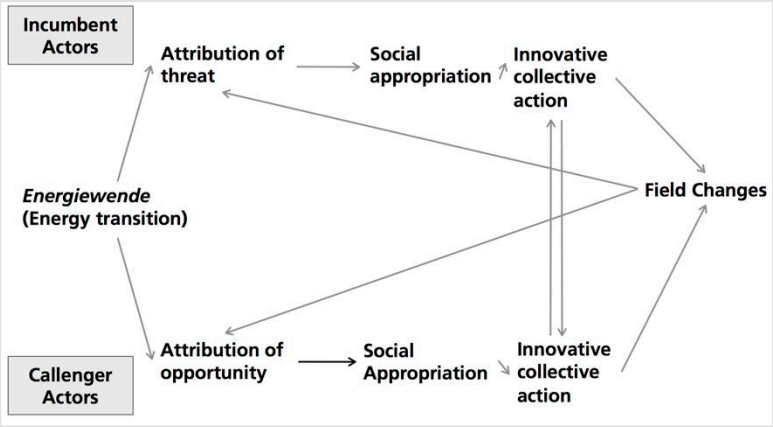
2.3 The Four Projects

The projects deal with the sources of change and stability in the institutional life of modern society using the example of the transformation of the energy sector. The specific goals of the projects are as follows:

Projects one and two analyze the adaptive capacities of the sector and study whether the politically envisaged *Energiewende* can be achieved by the incumbent actors and the established governance structures. Organization theory takes into account the actions of firms and distinguishes between strategies of search and adaptation (Lazonick 2005). Strategies of adaptation alone are not sufficient in a process of transformation. It is an open question whether the incumbent actors in the energy sector can successfully develop search strategies that lead to a transformation of the energy system, a transformation that may potentially alter the incumbent's positioning.

Project three — Market Creation, Institutionalization and the Role of Change-Agents — analyzes processes of market creation based on new technologies, and driven forward by challenger actors who act as change agents. Using the vocabulary from field theory, we talk about an emergent strategic action field. Recent studies have specifically emphasized sustainable innovation processes that develop within protective niches, where an alternative socio-technical path — with its own structural features, rules and actors — gradually unfolds. It does not, however, quickly develop into an existential challenge to the established core of the sector. Instead, it evolves over a longer period of time independent of and yet parallel to the established path (Kemp et al. 2001; Geels/Schot 2007).

Fig. 3: Changes in a Strategic Action Field

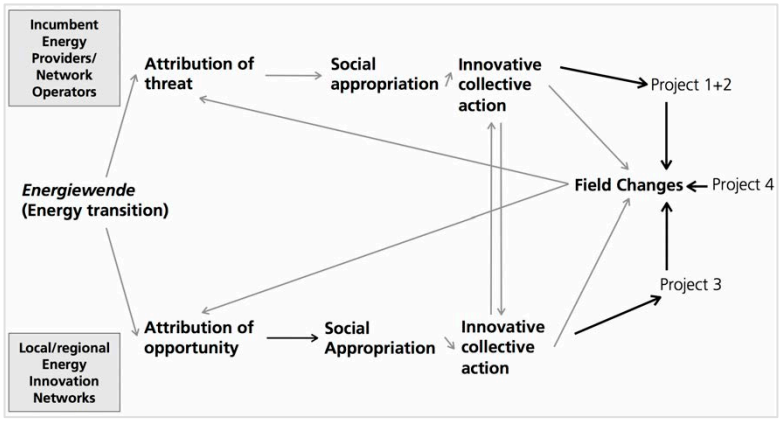


Based on Fligstein/McAdam 2012: 20

Project four — Patterns and Variants of the Gradual Socio-Technical Transformation of the Energy Sector — continuously analyzes and assesses the sector as a whole and the possible outcome of the transformation process. This assessment will be based on the results of subprojects one to three. Different pathways of transfor-

mation are foreseeable with different consequences for consumers, regulatory structures, and technology development. Rather than the aforementioned gradual, reform-oriented transformation, a more radical variant could also be envisaged based upon the success of the strategic action of challenger actors and the technologies they are favoring. Results will include new knowledge on the adaptive capacities of the sector, on the specific role of established actors or organizations, and on the role and importance of challenger actors acting as change agents. On this basis, different pathways for transformation will be identified and assessed. The continuing assessment and empirical analysis of the transformation of the German energy system as a whole will provide an empirically grounded insight into the possibilities, conflicts, and patterns of organizational and institutional change of a large technical system.

Fig. 4: Analytical Steps Taken in the Project



2.4 Methods Used

In contrast to a quantitative, linear research strategy, a circular approach is pursued that enables a dialogue in the research process between data collecting methods and data analysis (Lamnek 2005: 195). The methods used in the three projects are mainly document analysis and expert interviews.

Document analysis is based on a range of documents: official publications from energy providers; reports and documents from government agencies; reports by the media; and legal documents. Expert interviews will be used to close any gaps and to help in understanding complex matters. Experts are often able to provide critical feedback on the sources being used. Interviews might also help in gaining a better understanding of an actor's world view. Interviews will be conducted with representatives of relevant actor groups and organizations.

In addition project two forms focus groups of relevant actors from the respective fields. Project three carries out its expert interviews in the context of social network analysis.

3 The Role of the Leading German Energy Providers in the Transformation of the German Energy System

3.1 Research Questions

As stated at the beginning of the paper, the German energy system is in a phase of transition. Since the start of discussions on climate protection, energy efficiency, and renewable energies it has taken time for changes in the energy system to become apparent. While at a decentralized level new actors have entered the system, producing energy from renewable sources, it did seem for some time as if the four big German energy providers would try to ride out the situation, hoping for a lifetime extension of their nuclear power plants and a hold on their dominant position in the energy supply system. Indeed they have — as already mentioned above — put lots of effort into preventing a quick diffusion of renewable energies — at least in Germany. It is widely acknowledged for example that the "Big-4" (E.on, RWE, Vattenfall, and EnBW) drove up electricity prices between 2003 and 2006 by coordinated rigging (see Becker 2011: 184). The higher prices were blamed on renewable energies — which in fact had had a price-lowering effect on the energy resell market.

Following the Fukushima nuclear accident, the German government again decided for a phase-out of nuclear energy — this time with a greater commitment. An extension to the operating lives of nuclear power plants has thus become more remote. The nuclear moratorium has cost the energy providers billions of euros. Additional profit losses are also expected to be huge from the gradual phase out of nuclear power by 2022.[4] The "Big-4" now find themselves in a difficult situation: there is a limit to the compatibility between electricity generation from renewable sources and from fossil/nuclear energy sources. This is due to the fluctuating power generating curves of renewables and the limited flexibility of conventional plants to accommodate demand changes. Since renewable energies so far have been prioritized when fed into the grid — as demanded by law — they have increasingly acted as a substitute for electricity generated from conventional power plants. Higher investment in renewable energy sources by major energy suppliers would mean that renewables would create additional competition to their own conventional power plants. But to refrain from such investments would be akin to surrendering the German electricity market to the competition. This is a brief outline of the current situation in the German electricity market from which this project's research questions have emerged.

[4] The companies estimate that losses are running at around 15 billion euros. They have initiated court proceedings in order to get the government to cover potential losses. http://www.zeit.de/wirtschaft/unternehmen/2012-06/energieunternehmen-entschaedigung-atomausstieg, last accessed 13th July 2012.

Project one explores the question of how the four big German power companies (E.ON AG, RWE AG, EnBW and Vattenfall Europe AG) position themselves in the changing energy supply system. Which strategies do they use to defend their leading position and how do these strategies affect the course of the "energy transition"? How did they perceive the decisions made by the Federal Government — primarily as a threat or an opportunity? Did they begin making organizational changes to cope with the *Energiewende?* Can attempts towards a new coalition building be detected? What new or innovative measures have been enacted? The strategies by the energy providers are analyzed on a broad empirical foundation and studied using a theoretical framework derived from organizational sociological discourse. The aforementioned questions are particularly relevant because they deal with organizational inertia — a potential obstacle to the transformation of the whole energy supply system.

3.2 Theoretical Background

The theoretical embedding of the project is of major importance. On the one hand, the research design is developed with reference to the theoretical background presented at the beginning, while on the other hand, the final results are analyzed with a view to further developing the canon of theory within the sociology of organization. The work attempts to understand the organizational structure of the energy system and especially the dynamics of change. Fligstein and McAdam's theory (2012) offers a dynamic, action-centered method of understanding that is preferable to more static system-oriented theories — especially in regard to the thematic framework of our research that focuses more on change than on stability.

Fligstein and McAdam worked out an actor typology appropriate for the work here. With reference to this typology, the "Big-4" can be characterized as *incumbent* actors. They wield disproportionate influence within the field. The purposes of the field, at least in the past, have been shaped to their interests. They also possess most of the field's resources, and existing field rules mainly tend to favor them. The *challengers* on the other hand are in a less privileged situation and try to utilize every chance of gaining influence, and question the rules of the field. They are mainly represented by "new" actors emerging at decentralized levels. In addition, various *governance units* exist within the field who advocate the interests of the "Big-4" and attempt to maintain the field's dominant logic. They are distinct from actions of the *state,* which in Fligstein's and McAdam's theory is conceptualized as an exogenous actor that has huge potential to wield influence on the field and to threaten the incumbents (Fligstein/McAdam 2011: 5 ff.).

Applying Fligstein and McAdam's theory to the energy transition in Germany, the strategic action field "diffusion of renewable energies" has, (at least) since the turn of the millennium, been in a state that can be characterized as organized and unstable and open for transformation. This state has sustained a sense of uncertainty/crisis re-

garding field rules and power relations, a sense shared by the actors involved, which has allowed challengers to sense opportunities of increasing their influence. This has led to innovative action — resulting initially from actions by the challengers. The ongoing process has been marked by sustained mobilization (and innovation) by the incumbents as well as the challengers. Fligstein and McAdam term the described episode as an "episode of contention", defined as "a period of emergent, sustained contentious interaction between … (field) actors utilizing new and innovative forms of action vis-a-vis one another" (Fligstein/McAdam 2011: 9). This episode will last as long "as a shared sense of uncertainty regarding the structure and dominant logic of the field persists." (ibid: 2011: 10). The direction of the field's transformation remains open. Fligstein worked out different possible directions of change (as mentioned at the beginning). Analyzing the energy providers' strategies offers an opportunity to empirically assess the explanatory usefulness of this typology.

A further focus concerns the interdependencies of changes within the field as well as those within the involved organizations. According to neoinstitutionalist theory, these interdependencies primarily affect the institutional logics that underlie actions within the organizations as well as within the field. Changes in company action patterns, for example, may refer to processes of adaptation to changes in the field logics. On the other hand, changes within companies may affect the logic of the field — because of their institutional power as incumbent actors. A shift in field logic or within the organization can also lead to structural changes in the field as well as in the organizations (see DiMaggio/Powell 1983 and Meyer/Rowan 1977: 345). The project will thus address the theoretically important question of whether and how organizations are able to control their environment and initiate changes in their favor.

At a more general level, the work here focuses on the networking activity between actors, on the power structures within the field, on the mutual relatedness of the actions of actors, on the relevance of external factors to the actions of actors, and on the structuring of the field as a whole. It explores how flexible the field is at adapting to societal challenges and the factors that foster or hinder this flexibility.

3.3 State of the Art

An initial overview on the state of art of relevant research into the transformation of the energy supply system gives the impression that most studies either deal with the methods that support a further diffusion of renewable energies, or describe possible scenarios for future developments. These studies explain only insufficiently limiting mechanisms and opposing forces (especially the incumbent energy providers). There are in fact several very interesting studies that deal with the "Big-4" (see below) but they are either based on a different disciplinary perspective or are theoretically unsatisfactory.

Especially within the past ten years, plenty of studies have been carried out either on the general topic of renewable energies or on the more recent "energy transition". Many of those studies have been launched by organizations which are directly or indirectly affected by the energy transition's progress, organizations such as RWE or Greenpeace. The scientific integrity of these studies is questionable. Scientific research on this topic has generally been from different academic perspectives — the most active has been the economic sciences. The focus of research differs widely and reveals which areas are affected by energy transitions and, in turn, which factors impact on the transition of the system. Central topics include: environment and climate protection; developments and mechanisms of the electricity market; relevance of changes in energy law; the role of decentralized production structures; and the effect of developments at a European as well as at a global level. Several comparative studies of developments within different countries have also been performed (see Mallock 2012: 44ff.). The activities of the "Big-4" are connected with all of these issues. Despite (or perhaps because of this) they are treated only marginally in most cases, and considered as being one of many relevant actors. Examples of exceptions to this — i.e. studies that focus primarily on the "Big-4" — include: Marquardt and Bontrup's (2011) work on the German electricity industry; the study by Hirschl et al. (2011) on the investment in renewable energies by the big energy companies; the "Stromwatch" series by Leprich (2009) and Leprich/Junker (2010); and Becker's legal work in which he predicts the fall of the big energy suppliers (2012). Nevertheless, these studies offer no satisfactory answers to the above-mentioned research questions. Obviously, no studies exist on developments within the industry since the Fukushima reactor accident[5]. This event can be seen as a turning point because it resulted in the German government again deciding to phase out nuclear power — this time with greater commitment. A real change in the strategies of the "Big-4" is therefore more likely than ever before. Due to these two factors, a comprehensive analysis of the subject from a sociological viewpoint is thus overdue.

3.4 Project Program

The empirical part of this project is a two-step reconstructive study of the activities of the "Big-4". The first step concerns document analysis followed in a second step by expert interviews. Reconstruction of the activities of the Big-4 starts at the year 2000, a turning point in German energy policy with the "Law on the Priority of Renewable Energies" coming into force and the parliamentary "Nuclear Consensus".

The document analysis mainly focuses on the *activities* of the "Big-4" – such as investments/divestments, changes in internal structure etc., how the Big-4 perceive the

[5] Becker names some effects of the accident but doesn't deal with the potential further impact. The period he analyzed ends shortly after the accident.

energy situation — and the *events* in the field and field environment — such as changes in the law or exogenous shocks. Analytically, the study has three main focal points: (1) corporate actors: long-term consistency of strategies, phases of reorientation and changes in strategies as well as reactions to environmental change; (2) actor comparisons: similarities and differences in strategies. We assume that in periods of contention, incumbent actors differently interpret what a field is all about and what its organizing principles are; and (3) interdependency of strategies: action-reaction patterns. The system of categories to be applied in the analysis are based on Fligstein and McAdam's theory of strategic action fields.

The study design is also based on the assumption that the above mentioned interdependencies between field, organizational logics, and structures are empirically observable and that information about these interdependencies can be extracted from the available documents and actor statements. Structural changes within the organizations can be drawn from annual company reports. It has to be assessed whether (or which of) of the changes can be interpreted as reactions to changes in the field. Management changes, for example, often seem to occur in times of great uncertainty or change. Change in the logic of the organization and the field are more difficult to detect. Change in the public relation activities by companies can be used as a possible indicator. Because linkages between field change and organizational change in most cases are ambiguous, a systematic indicator system for the analysis is developed. It has to operate at the two dimensions of logics and structure. Interdependencies between these two dimensions also have to be taken into account.

The experts to be interviewed are selected after the document analysis — the data the analysis generates may open up new insights that need to be considered in the interviews. The selection criteria is thus derived from intermediate outcomes. The interviews offer an opportunity to fill potential gaps in information and to follow up questions that arise in the course of research. As a secondary effect, the interviews may be used to prove the validity and reliability of the document analysis.

3.5 Expected Results

In summary, the project attempts to achieve multiple aims. On the one hand, the empirical study is intended to draw a detailed picture of how the strategic positioning of the "Big-4" evolves. This includes how other actors in the system influence the "Big-4" as well as the reactions of the "Big-4" to events in the field and the field environment, the development of strategies, and the effect on one another of the adaption of strategies. On the other hand, the results — reflecting on the theory canon — are intended to contribute to the theoretical discourse on the organizational dynamics of socio-technical systems and strategic action fields.

4 The Integration of Volatile Renewable Energies into the German Electricity System. The Role of the Established Power Industry in the Extension of Electricity Grids — A Comparative Case Study

4.1 Research Questions

Today, about 20% of the energy supply comes from renewable energies, mostly produced by small to medium sized independent actors. But the volatile power producing technologies, especially wind and photovoltaic, are still not fully integrated into the grid. In order to raise the share of renewable energies from 20% to 80%, or even just to 40%, a planned grid extension are deemed necessary. This means that a point is soon to be reached where renewable energies can expand only with the active support of grid operators.[6] In 2009/2010, the ownership structure of the grids changed. Prior to then, the Big-4 energy providing companies ran the grids; three of the four German transmission grids are now no longer operated by E.on, RWE, and Vattenfall, but by actors who are not themselves owners of power plants (see Figure five).

Fig. 5: Grid Operators in Germany

Source: McLloyd 2012

[6] An alternative to grid extension — which today seems to be rather unrealistic — would be a far-reaching decentralization of energy production.

This is increasing the complexity of the system and will also pose a special challenge for the planned study here. History, of course, does matter: it is important to differentiate between cases in which the new owners are making "their own" decisions and the cases in which they may be influenced by strong path dependencies produced by the decisions of former operators.

In 2011, after the Fukushima accident, a Grid Expansion Acceleration Act was passed which, in order to accelerate the grid extension process, put more of the decision-making power into the hands of the Federal Government. A number of issues have to be addressed: How centralized or decentralized is the grid to be? How big is the actual need for grid extension? What about the relationships to neighboring countries? Should new power lines be built overland or underground? What are the precise locations for new transmission towers and cables? Who will ultimately have to pay? What is an appropriate timetable? Differing actors are involved with diverging interests and ideas as well as "core beliefs" that have different answers. The central research question is: in how far, and why, would the incumbent actors realize their aims concerning technical implementation of grid extension. As described above, an expansion of renewable energies would result in potential economic losses for the main incumbent actors. We therefore have a situation in which large parts of society (who favor of energy change) expect — more or less consciously — the big operators of base-load power plants to actively act against their own interests. The big operators are legally required to provide preferential grid access to new wind and photovoltaic devices, and also to ensure grid stability. This places them in a difficult situation, at least in respect of the German market.

On this basis, the study deals with the question of how the incumbents act when faced with the challenge to maintain their dominant position while defending their own interests. In order to reach a proper evaluation of their strategies, four fields of action are analyzed in detail. Based on the analyses of each individual field, conclusions are drawn on whether, and how, the incumbents are coping with new external demands, and to what extent they are able to influence expectations coming from the external environment. The way the grids are extended may provide insight into how far it is possible to achieve 100% of electricity from renewable energies by 2050. In this manner, the results also contribute to project four which deals with more general aspects of the transition of the electricity system.

4.2 State of Research

Numerous studies are meanwhile available which analyze the role of renewable energies in the German electricity supply system from a social science perspective. A comprehensive account of the state of research can be found in Byzio/Mautz/Rosenbaum (2008: 30 ff.). Of special interest are studies which refer to the systemic relationship

between new energy supply technologies and the established system. Only a very few studies fulfill these criteria (see Mautz/Rosenbaum 2011: 416): Mautz 2006, 2007; Byzio/Mautz/Rosenbaum 2008 and Mautz/Rosenbaum 2011, 2012) analyze the role of renewable energies in the established electricity system from an institutionalist perspective. According to Mautz, the process of integrating renewable energies is not yet complete. Different variants of integration are possible (see above). Ohlhorst (2011) analyze the constellation of actors within the electricity system from a governance perspective. Conflicting interests exist between the proponents of renewable energies and those of big fossil and nuclear power plants. On this basis, it cannot be assumed that the latter will become a driving force in the energy change (Ohlhorst 2011: 77).

Very important to the research on grid extension are studies from the economic and engineering sciences. A central reference point of most studies dealing with this topic are the "Grid-Extension-Studies" from DENA (2005, 2010), which have become the basis for grid extension policy. Jarass (2010) criticizes the oversized grid extension proposed in these studies. He expects that a large share of the planned extension is to be used to secure the profitability of new coal power plants (Jarass/Obermair 2009). According to Hohmeyer et al. (2011), there is no need for any grid extension prior to 2015. Of relevance are also several studies by the *Sachverständigenrat für Umweltfragen* (esp. 2011). Furthermore, the grid operators themselves often publish detailed plans about their new power lines. These plans are usually based on results from the DENA studies. Alternatives such as underground cables and high-voltage DC-transmission lines have been rejected because they are technologically unsound and/or too expensive. A research group of psychologists (Rau et al. 2010) examine the reasons why people oppose grid extension in their home regions, using the region of Wahle-Mecklar as an example. One of their most important results reveal that new power lines would be acceptable to most people as long as the lines transported renewable rather than fossil energies (ibid.: 10).

4.3 Project Program

4.3.1 Theoretical and Conceptional Basic Assumptions

The theoretical basis of the comparative case study is the concept of strategic action fields as developed by Fligstein/McAdams (described above). They understand social developments as actor-driven and focus especially on disputed action fields. This analytical approach therefore suits the investigation of the different areas of grid extension to be examined in this study.

The actions of actors — challengers, incumbents, protest actors, and government — are analyzed. Depending on the field structure, the relationships between these actors differ. For each field, the Federal Government is a very important external actor. It plays a central role in creating these fields and sets the legal framework. Technically,

the main aims of grid extension are the system-integration of volatile renewable energy and the guaranteeing of grid access to renewables (see below). This arises from the wider government objective of changing the energy system to renewable energies. Up to the 1990s, the Federal Government's energy policy had broadly been in line with the interests of the energy companies. Support for renewable energies then led to a partial drift between the two. The issue of grid extension may aggravate this discrepancy.

This study analyzes in how far the incumbents are successful in maintaining their position while being challenged by a further extension of volatile renewable energies. Grid extension measures are a process of incremental innovation. Sociological innovation research reveals that when a field structure with a given balance of power is confronted with an external pressure to change, it is possible to be defended by the powerful actors when the challenge can be mastered by a process of gradual adaptation (e.g. Dolata 2011a).

4.3.2 Complex Field Structures

For the "energy supply" integrative field, it is relative easy to identify the main challenger-role: the operators of renewable energy devices. As they have no responsibility for grid extension, they are of secondary importance to the sub-fields of energy supply being considered here. These grid extension fields include actors who oppose construction projects mainly for local reasons (concerned citizens, but also larger organizations at regional and national levels: e.g. tourism businesses, fishing associations, and nature conservation organizations). Their positions are situated beyond the "energy policy front-line"; i.e. the conflict whether or not to implement far-reaching change to renewable energies. As long as these protest actors neither fundamentally criticize incumbent strategies nor enter the energy generation business, they cannot be labeled "challengers" (Fligstein/McAdams 2011). Nevertheless, their actions are an important element of the study. If it is true that the grid extension obligation on grid operators is harming protest-actor interests, they may attempt to delay construction which then needs to be considered. Two kinds of actor are therefore opposing, or may oppose, grid extension; but for totally different reasons.

The real challengers — who may or may not be part of the market — are those actors, who directly attack the strategies of incumbent actors. Depending on the field situation, these actors may either favor or oppose planned building measures. In some cases they argue that incumbents are delaying grid extension. In other cases they criticize incumbents for steering construction projects into directions which (at the least) do not primarily foster better system-integration for volatile renewable energies.

4.4 Case Selection

Different action fields exist in which the extension of electricity grids to give access to new (renewable) power plants and to improve system integration of volatile renewable energies is at stake. The four cases examined in this study fulfill the following criteria:

- The study examines how the system integration of volatile renewable energies is driven forward by grid extension. To achieve representative assessments, the selected fields must be crucial for the whole process (*relevance criterion*).
- At the center of interest is the action of actors. In the analyses of fields with (very) new technologies, the study needs to pay special attention to these actors. To achieve for highly-focused results, only fields with well-proven technologies are considered (*proven technologies criterion*).
- The study concerns the role of the established power industry. One of the large electricity companies therefore needs to be, or have been, a main incumbent actor of the analyzed field. The latter possibility reflects the general shift of transmission grid operators. To analyze and evaluate the importance of the Big 4 (also in a possible contrast to the new operators), requires that they have had a dominant position in this field (*Big-4-involvement criterion*).

These criteria are met by the following action fields: a) Extension of the 380kV grid; b) Extension of regional 110kV-grids; c) Grid access for offshore wind parks; d) Interconnectors between Norway and Germany.

4.5 Case Studies of Strategic Action Fields

4.5.1 Extension of the 380kV grid

The transmission grid requires extension due to the large wind power capacities planned for the northern parts of Germany, especially in the North Sea. It will then be possible to transport power from the north to the energy consuming economic centers in the west and south of Germany (e.g. Ruhr- and Rhein-Main-Region).

This action field is characterized by a high degree of complexity and diversity. There are many actors with differing concerns, arguments, and interests, who directly or indirectly challenge the projects. The economic and technical performance of new technologies is assessed by the actors in competing ways. For example, there are actors who lobby for high voltage DC transmission lines. This technology is able to transmit energy over long distances with significantly smaller losses. In addition, DC power lines do not emit electromagnetic radiation. The risk of serious health damage from radiation is one of the main areas of controversy. The grid operators refuse however to apply DC technology due to its unfavorable return on investment.

Different methods are available to achieve grid extension. Disagreement on the best method exists between incumbent actors (including the Big-4) and challengers (local protest actors, environmental groups, local politicians, and scientists). The energy companies seem to be taking an active role within this action field. The central assumption concerning the field is that energy companies have succeeded in establishing a strategy which closely conforms to the general public interest and not just to their own interests.

The shift in transmission grid operators may not have a high impact in this field. The most controversial extension projects, and which are therefore the objects of this study, were started in 2005 and mainly planned by E.on, RWE, and Vattenfall.

Fligstein/McAdams (2011: 7) describe one typical type of incumbent-behavior: The incumbents attempt to "find some collective definition of interest" and "to mobilize support … for a certain shared worldview". We analyze rather successful attempts at doing this, especially in this field.

4.5.2 Enforcement of Regional Power Grids

In some cases, a lack of capacity for 110kV-lines means it is impossible to transport energy from specific regions (with no consumption) to the transmission grid. In these situations , utilities are obliged by the Renewable Energy Sources Act to extend the grid. In their own interests, some utilities seem to lack the motivation to do this quickly. In the region of Nordfriesland, E.on required nearly twelve years to build a new 28km-powerline. The aim of this section of analysis is to understand why some projects progress so slowly. Have grid operators purposely delayed the construction of new powerlines to transport large amounts of renewable energies? If so, why are they able to wield such a major influence? A significant problem is that overhead cables are generally unpopular. At the same time, grid operators often reject the use of underground cables at the 110kV-level. Because this technology is tried and tested — unlike that of 380kV AC underground cables — the delay by grid operators seems motivated by a reluctance of some sort. In Denmark, the utilities are obliged to install underground cables at the 110kV-level. Grid operators generally take a passive role in this field. They are unable to argue that underground cables at the 110kV-level are too expensive. In contrast, the Federal Government have improved the conditions for implementing this technology.

In affected regions, a new group of independent actors might emerge who become actively involved in the process of regional grid extension. This study analyzes how far these "active challengers" are able to disturb the incumbents' strategies.

The geographical focus is on the northern part of Germany where a high proportion of electricity is produced by decentralized wind parks. The study compares planning processes for 110kV cables between regions with "Big-4 operators" and regions with independent grid operators.

4.5.3 Grid Access — A Central Barrier for the Offshore-Wind Strategy

Offshore wind parks are usually situated at more than 80 km from the coastline so it seems justified to understand their grid access as a grid extension. Since 2006, the operator of the transmission grid at the landfall point must ensure grid access. The focus is therefore on E.on and Vattenfall, respectively Tennet and 50 Hertz, the present grid operators. It may take several years until construction permissions are granted especially in the North Sea where cables have to run through a large nature protection zone.

Three phases are identified. During the phase one (2000–2005), energy companies as "primary addressees" successfully slowed down the introduction of the offshore-wind power sector. Big-4 actors didn't approve any investment during this period, although they had planned several projects. Because of this, cable projects were not on the agenda. In the second phase (2006–2009) they became more active because from December 2006 they were forced by law to provide grid access to offshore wind parks. The third phase (since 2010) began with the shift of ownership of the transmission grids. For this action field, this shift may be highly important. New operators seem to lack the economic interest to prevent offshore wind parks from succeeding.

Phase one is characterized by a high degree of stagnation. Compared with progress in the UK's offshore wind sector, development in Germany's Baltic and North seas has been proceeding slowly. Nevertheless, the first projects have been started and two are now in operation. One bottleneck remains grid access, including sea cables. In fact, further development may be delayed despite new actors with differing interests such as Vattenfall and E.on (see above). Tennet, the successor to E.on, has already announced that the company will have problems building the offshore grid in the North Sea.

Unlike in the fields for regional and transmission grid extension, it is difficult to say whether incumbents are primarily active or passive. Important for this field is the time-aspect. The change in grid operators is not part of the kind of field transformation referred to by Fligstein/McAdams. It isn't a "victory" for challengers who formerly had a weak position in the field, but rather a top-down guided change of incumbent actors. So, according to Fligstein/McAdams, the change in grid operators will not necessarily lead to high activity within the field.

4.5.4 Access to Norwegian Hydro Power Plants

One possibility of integrating large-scale wind power into the electricity grid is to use Norwegian hydro power plants for back up. In windy periods, power from German offshore wind parks could supply energy to Norway. Cables through the North Sea are therefore necessary. The same cables could of course be used for different purposes. To ensure that any connections are actually used for stabilizing the Ger-

man power grid — and not for selling electricity at maximum-prices at times of high demand — requires coordination between governments and companies. Nevertheless, the technical infrastructure remains the same and it requires time to install it. Once it is built, decisions can then be made on "correct" usage. It may not be in the interests of the major energy companies to accelerate the installation of such cables. Depending on the cables' transmission capacity, Norwegian hydro power could become another competitor to the coal and nuclear power plants of northern Germany.

In line with the Fligstein/McAdams-concept that broad changes are not usually initiated by incumbent actors, and considering the economic interests at stake, it cannot be assumed that (Big-4-)incumbents will play an important role in this field.

E.on's "Viking Project" of the late 1990s is an example which confirms this assumption. Once this cable-project — the first that would connect Germany and Norway — had been authorized, E.on cancelled it. Today, there are other actors, mainly from the Norwegian side, who are uninterested in realizing the cable infrastructure: namely the Norwegian state, and the oil and gas industry (Midttun et al. 2012). For this reason, the field may not be very helpful in analyzing the role of Germany's large utilities. It would be hard to prove whether stagnation is primarily due to reluctance by the energy companies. E.on's successor, Tennet (the operator of the Netherlands' transmission grid), is displaying higher activity in the field. In 2006, Tennet constructed a high voltage DC cable between Norway and the Netherlands (in cooperation with the Norwegian grid operator Statnett). Both actors — supported by the German government — are planning to build a power line to the German North Sea coast by 2018. The shift in grid operators may therefore be important in this field.

4.6 Expected Results

The study primarily aims to contribute to a sociological understanding of energy transition, especially concerning grid extension (e.g. the role of old and new grid operators, changes over time, power structures, influence and positions of different challenger groups). From this, we expect results concerning the capability of incumbent actors to support or hinder energy transition.

The results will also be applied to the discussions on the change of socio-technical systems. Different positions are to be found in the literature on fundamental change in large technical systems (Mayntz/Hughes 1988), in sectors (Dolata 2011a), or in strategic action fields (Fligstein/McAdams 2011). The findings on whether incumbents are willing or reluctant, capable or incapable of developing the infrastructure required for energy transition, are interpreted on the basis of these different concepts and contribute to project four in this way.

5 Challenging the Established Consensus? Local/Regional Initiatives and the Transformation of the Energy Sector

5.1 Research Questions

While the traditional form of power generation and supply is based on centralized structures with large-scale power plants, the objective of a strongly decentralized form of energy supply is increasingly becoming of importance. With this upcoming new paradigm, the challenges from the energy transition are relevant not only to policies at a European, national, or state ("Bundesländer") level. In existing regulatory and market frameworks, important technical and institutional innovations for the *Energiewende* have been developed, tested and applied at regional levels. Regions that experiment with socio-technical innovations and implement new concepts must develop governance structures under highly uncertain conditions. New governance arrangements emerge (Joss 2011) and need to be tested for persistence and functionality.

In this context, the project analyzes the development of regional situational governance that serves as a basis for innovation impulses to transform the energy system. The study assumes that regional governance structures develop in conflict with the field's established structures and analyzes four German regional projects in the south of Germany as fields where socio-technical innovations take place. Based on the aforementioned theory of strategic actions fields, the study aims to analyze challenger actors who perform as change actors (Rogers 2003: 365ff.). Such actors may eventually contribute to an overall system change by creating new markets. These markets underlie the development of a new institutional context that is based on learning processes within innovation networks.

Challengers recognize the nature of the field and the dominant logic of incumbent actors and are then able to articulate an alternative vision of the field and their positioning within it by "awaiting new opportunities to challenge the structure and logic of the system" (Fligstein/McAdam 2011: 6). The challengers are aided here by social skills, by engaging other actors, and by the resultant collective action. Based on Fligstein/McAdam (2011: 9), we can expect that even when a single member (i.e. an initiative) of the field begins to act in innovative ways by violating field rules, others will respond in a similar way, precipitating an episode of contention. Challengers then sense an opportunity to use new methods to advance their position in the field and are thus likely to engage in innovative action and sustain mobilization. They are then able to slowly begin to institutionalize new practices and rules (Fligstein/McAdam 2011:10).

The project focuses on local initiatives and conflicts resulting from the development of new energy governance at regional levels based on vague responsibilities of specific actors such as public-private partnerships and publicly initiated — but legisla-

tively privately organized — outfits. According to Adger/Jordan (2009), there are special difficulties with decentralized initiatives and their associated governance. But so far no systematic empirical studies exist that deal with this issue. The project therefore focuses on regions and local community experiments with socio-technical innovations which aim at realizing different and new objectives for the energy supply system. New actors have opportunities of intentionally constructing new paths.

The phenomena of emerging fields is studied focusing on actor constellations and using four case studies (small-N analyses). The case selection procedure is based on two observations. One refers to the definition of the population, the other to the selection of cases. The populations of potential cases can be defined as representative regions which embody the new paradigm of the German energy transition (100% energy from renewables). This means that regions represent a specific set of special conditions and social phenomena (Bradshaw/Wallace 1991) by constructing specific governance structures that underlie a goal of achieving an energy supply based on 100% renewable energies. The second argument provides the basis for the construction of a functional model. As shown below, the model consists of four cases (regional fields) based on differences in the composition of change actors. The model assumes that specific structural and organizational designs will be influenced by the type of actors and aims to sample the maximum of variation and heterogeneity to understand how the phenomena can be seen with respect to different change agents.

The project systematically compares the four cases. Open access to the concept of a case located between the distinctions of "empirical unit" and "theoretical construction" (Ragin 1992: 9ff.) should enable multi-stage research of "contrast oriented comparative" methods as well as that of "parallel demonstration of theory" (Skocpol/ Somers 1990) and thereby achieve an intensive ideographic case study (Eckstein 1975). Hypotheses of the theory of strategic action fields (Fligstein/McAdam 2011) are modeled on Ragin's variable based comparative method (in which qualitative data can be used instead of quantitative data) and based on the selected cases. They undergo testing and a comparison is made of the influence of specific variables. The aim is to recognize general patterns rather than focusing on individual cases, patterns which result from the energy transition (Kohn 1989a: 21, quoted by Bradshaw/Wallace 1991: 158).

Table 2: Cases and Actor Constellations

	Profit orientation	**Public interest**
External actor involvement	Solarcomplex AG	Regionale Innovationsagentur "Regina" GmbH
Endogenous actors	Abfallwirtschaftsgesellschaft des Neckar-Odenwald- Kreises mbH (AWN)	Südschwarzwald e.V.

Case 1: Hegau Bodensee region, private actor: In this region, the goal of energy transition is being driven forward by the Solarcomplex AG. The company works as an alternative municipal utility and aims to supply the Bodensee region with 100% renewable energies by the year 2030. The Solarcomplex AG invests especially in solar energy and bioenergy villages. It acts as a driving force and can be seen as a pioneer for developing business cases in the field of renewable energies.

Case 2: Neumarkt in Upper Palatinate region, public-private actor: The regional management of the development concept for achieving a 100% renewable energy supply is coordinated by the regional innovation agency Regina. It is run and supported by a host of actors from within and outside the region (e.g. the Bavarian Ministry of Economic Affairs, Infrastructure, Transport and Technology, the Bavarian State Ministry of Agriculture and Forestry, the Bavarian State Ministry for the Environment and Health, the European Union, Neumarkt Savings Bank in Upper Palatinate, Neumarkt Raiffeisen Bank in Upper Palatinate). The region acts according to sustainable regional development, including the supply of 100% renewable energies.

Case 3: Hohenlohe-Odenwald-Tauber region, Verband Abfallwirtschaftsgesellschaft des Neckar-Odenwald-Kreises mbH (AWN): The Bioenergy Region Hohenlohe-Odenwald-Tauber is run by the *Abfallswirtschaftsgesellschaft* (AWN — Waste Management Company). It is a profit oriented company, 100% owned by regional public bodies. The region aims to become a zero-emission region by supporting the generation of renewable energies.

Case 4: Region Southern Black Forest, Südschwarzwald ev.: The key actor in the campaign *Bioenergyregion Südschwarzwald plus* is the association *Südschwarzwald e.V*. It has been set up by five counties. The campaign is driving forward the expansion of bioenergy in the region with the aim of supporting municipalities and villages towards becoming biomunicipalities and biovillages. It stresses the use of existing biomass which is intended to bring together available natural resources, social structures, as well as climate and environmental goals.

The project focuses on challenger actors and new actors within the selected regions and analyzes their significance in creating new, or transforming existing, fields. By reinterpreting a field, the actors undermine and confront traditional path dependencies, which then results in the emergence of new power structures. Skilled social challengers are able to provide the impulse for fields to emerge. Existing rules and resources have to be translated into the production of local orders by convincing their supporters to cooperate and finding means of accommodation with other groups. Challengers can also help to produce entirely new cultural frames for the field by building compromise identities or transforming the existing group identities and interests and ultimately being able to produce new forms of organization (Fligstein/ McAdam 2011: 11ff.).

The aforementioned changes in the structure of actor constellations along the innovation chain require not only new impulses for existing innovation networks. These processes need support from new institutions and regulatory mechanisms, so called governance units, which "are charged with … overseeing compliance with the field rules and, in general, facilitating the overall smooth functioning of the system" (Fligstein/McAdam 2011: 6). The transformation of strong path dependent socio-technical regimes, as well as the development and coordination, under time pressure, of policies that are functional, efficient, and appropriate, confront political, economic, and civil actors with new types of governance problems.

In this context, new actors attempt to minimize, control, and overcome the particular risks that occur in the transformation process by integrating into networks and actively participating in network creation. Skilled actors will engage in moves that they hope will improve their positions in the strategic action fields (SAF) (Fligstein/ McAdam 2011:14). These constant adjustments constitute a form of organizational learning which can be organized by the deliberate involvement into more or less organized innovation networks. Network relationships offer numerous advantages for new actors or challengers. Direct and personal relationships enable information and new knowledge to be efficiently acquired, transferred, and exchanged. Networks enable challengers to react more quickly and flexibly to technological and economic change. Predominantly local and regional relations are important, especially during the early stages of a transformation process, as actors rely on their personal contacts. Relations can then be extended later to other levels. These types of networks serve to support innovation processes. They can be characterized by the coexistence (and partial co-operation) of differing, mainly public institutions (intermediates) which support the foundation of new enterprises. These networks are generally open to all participants and have the primordial function of reducing information deficits and making finance accessible to new companies in the early stages of their development. Moreover, they serve to conduct the increasingly interactive innovation processes and to establish links between different actors.

The project's overall objective is therefore to analyze specific structural and organizational designs of regionally located governance that has and is being established by the action of the actors involved. Changes in the organizational and institutional environment are identified as well as forces that drive, stabilize, and limit transformation to the overall field of energy generation.

5.2 State of Research

The socio-technical approach to the analysis of transformation processes has put forward major findings over the past few years. Based on the relevant research, the project strengthens those areas that current research underexposes. Although research

on the transformation of energy systems includes detailed studies that focus on special, often technical defined subareas of energy systems (integration of nets, different forms of generation), such research mainly concerns conceptually oriented studies that emphasize in particular the political and institutional aspects in different countries. Less wide spread are studies which consider both the socio-technical character of energy systems and the specific spatial conditions of innovation and spatially concentrated potential. Analyses are also lacking that both explain transformation processes and examine typical complex actor constellations.

Different types of innovation systems can be identified depending on the focus, level, and purpose of analysis (Rohracher et al. 2008). Energy innovation systems are often conceptualized as national systems because energy supply systems are characterized by a strong state involvement (Lundvall 1992, Lundvall 2007), and are divided into different sector specific systems based on specific forms of technology such as wind energy, photovoltaics, or coal (Carlsson/Stankiewicz 1991, Malerba 2002, Carlsson et al. 2002, Hekkert et al. 2007). Technical innovation can contribute to stability and persistence as well as to radical change and modification to social relationships and structures (Dolata 2011a). This indicates a tension between technical innovations and social embeddedness, which constitutes the hybrid character of energy systems and therefore frames the starting point of socio-technical research on transformation. Important objects for the socio-technical research on transformation are energy systems and the factors that influence transformation processes (cp. Bergek et al. 2000, Coenen et al. 2010, Dolata 2008, Geels 2004, 2002, Geels/Schot 2007, Kern/Smith 2008, Rotmans et al. 2001, Rohracher 2007, Smith et al. 2005).

Studies that take a multi-level perspective (e.g. Geels/Verbong 2007, Geels 2005, 2010) identify dynamic processes that are characterized by path-dependencies and lock-in phenomena as well as by interdependencies between technical and social change processes (Elzen et al. 2004, Raven/Verbong 2010, Rip/Kemp 1998). Trajectories of persistence thereby hinder change and are hence very interesting for analyzing the reluctance to withdraw from fossil path dependencies. But there is a lack of studies on actor orientation, on territorially focused strategies, and on innovation resources (Markand/Truffer 2008, Kemp et al. 2001). Even though the innovation niches that are central to analytical studies have been attributed to local characters, the spatial embedding of innovation processes, and the dynamics of innovation there, negotiation processes and the "battle of the systems" have been neglected (Monstadt 2009, Hodson/Marvin 2010). This may reflect an uneasiness in sociological thinking concerning the relationship between social and geographical space (see Martin 2009).

The theory of strategic action fields seems to be able to address some of the critical points mentioned above and seems especially well suited for our purposes since it claims to answer the questions of how, and under what conditions, relatively powerless actors are able to mobilize and (re)organize fields — in our case energy infrastructures.

Strategic action field theory aims to analyze the actions of challenger actors at a regional level, actions which eventually might contribute to a change in the overall system.

5.3 Project Program

Regional governance seems to be playing an increasingly important role as a driver for energy transition. A number of regions support demonstration projects and are building networks that involve regional actors. The project analyzes the strategic actions of challenger actors or new actors to the field. Within these regional contexts, challengers occupy less privileged niches and usually have less influence over regional operation. While they recognize the nature of the field and the dominant logic of the incumbent actors, they are usually able to articulate an alternative vision of the field, its basic technologies, and their positions within it. The main research interest is therefore the reconstruction and empirical analysis of decentralized energy provision concepts. Based on the theory of strategic action fields, the project program aims to maintain and develop a research framework which includes the theory's three main parts: in addition to innovative action, the onset of contention also depends on two "significant hallmarks" (Fligstein/McAdam 2011: 9ff.). One prerequisite for an initial episode of contention[7] in our case is a shared sense of uncertainty/crises regarding the rules and power relations that govern the field; the second episode emerges from a sustained mobilization by challenger actors.

The project's approach can be divided into five parts. The following research steps do not take place consecutively but are conducted partly in parallel and will overlap. It is obvious from the methods being used that the actual work is arranged as a dynamic feed-back process and not as a linear strategy.

5.3.1 Who Are the Key Actors and Who Can Be Generally Viewed as Possessing More or Less Power?

The analysis assumes that there is a set of relatively fixed actors in the field whose roles and comparative status/power is consensually defined by others in the strategic action field, and then tries to identify/(re)construct the regional field's structure. Qualitative network analysis will be used to model the assumptions of strategic action field theory. Network analysis provides insights into the positions occupied by different actors as well as into the structural composition and dynamics of the network itself. Social network analysis can therefore be used to develop a typology of different network structures and network compositions as well as to derive some predictions on how well these structures and compositions are suited to serve specific

[7] An episode of contention "can be defined as a period of emergent, sustained contentious interaction between … field actors utilizing new and innovative forms of action vis-a-vis on another" (Fligstein/McAdam 2011: 9).

purposes. The mapping and analyses of capital (Burt 2000, Hanneman/Riddle 2005, Freeman 1991) as well as an analysis of the available resources — material, political, ideological — will identify the most powerful actors in the regions and enable conclusions to be drawn about the taxonomy of innovation networks (Schön/Pyka 2012). A classification of actors will help to reduce complexity and enable us to find disparities between the actors/parties regarding the resources they command, and identify potentially more powerful actors (Fligstein/McAdam 2012: 165).

5.3.2 Social Skills

Based on the assumption that "fields are constructed in the sense that they turn on a set of understandings fashioned over time by members of the field" (Fligstein/McAdam 2012: 10), three categories of these understandings are analyzed to identify the conceptions of strategic action that the key actors represent. The underlying conceptions and logics of action are analyzed and are expected to reveal different interpretative frames reflecting the relative position of actors within the strategic action field (Fligstein/McAdam 2012: 11).

(1) Alternative conception: What's going on, what is at stake? Can we find an overall account by the field actors of the field's terrain? What alternative conceptions of the strategic action field do these key actors represent?

(2) Cultural understanding: Which set of shared understandings can be found about the nature of the rules in the field? Do actors understand what tactics are possible, legitimate, and interpretable for each of the roles in the field?

(3) Frame: What interpretative frame do individual and collective strategic actors bring to make sense of what others within the strategic action field are doing?

With the concept of social skill, including the analysis of strategic action[8], this point will highlight "the way in which individuals or collective actors possess a highly developed cognitive capacity for reading people and environments, framing lines of action, and mobilizing people in the service of broader conceptions of the world and of themselves" (Fligstein/McAdam 2012: 15). The action of actors can therefore be analyzed depending on the role they occupy in a particular regional strategic action field.

5.3.3 Broader Field Environment

It is not only the internal units of incumbents, challengers, and government that play important roles in the restructuring of power relations within the field. There are also external variables and units, such as governance units or adjacent fields (Fligstein/McAdam 2011: 8) that can influence a genuine transformation. It seems obvious, es-

[8] The creation of identities, political coalitions, and interests.

pecially in the context of the energy transition, that developments in the field's environment play important roles. Identifying ties that violate the borders of the field help to identify links to the broader environment and to visualize lines of influence. The questions which should be discussed here concern the roles, if any, that external actors — especially state actors — play for the intermediate outcomes.

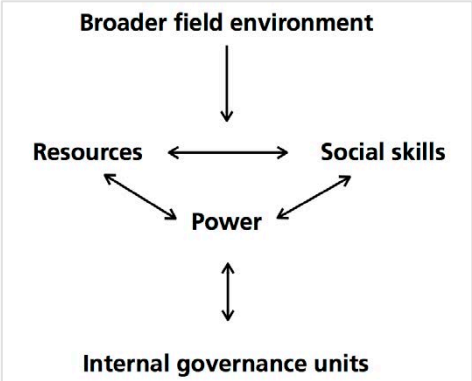
5.3.4 Internal Governance

Internal governance units are charged with overseeing compliance to field rules and, in general, facilitating the overall smooth functioning and reproduction of the system by reinforcing the dominant perspective and protecting the interests of the incumbents. Assuming that the state of the field depends on a generalized sense of stability and certainty, a consensus on the relative positions of incumbents and challengers (Fligstein/McAdam 2012: 22ff.), this point helps in understanding what internal governance units were established to aid in the routinizing and safeguarding of a possible institutional settlement.

5.3.5 Principle Terms of Settlement

This point concerns the analysis of the principle terms of the settlement recognizable at the end of the studied period. The relations between the units analyzed in steps one to four will be brought together and synthesized.

Fig. 6: Principle Terms of Settlement



5.4 Expected Results

The above mentioned project program attempts to apply the theory of strategic action fields with an emphasis on challenger actors or new actors who either establish new or change traditional socio-technical pathway dependencies, and therefore may be an important source of support for the energy transition.

The analysis aims to characterize new actor constellations as well as emerging pathways and new power structures. A classification of actors can also reveal the different modi of action related to different actor configurations that underlie the construction of the actors' cognitive explanations (collective construction of opportunity and appropriation) and collective frames of cognition. Analyses of barriers and driving forces that hamper or foster the further development of diffusion of renewable technologies can identify lines of conflicts as well as new approaches. The project therefore adds to the understanding of emerging pathways and the role and action of change agents in the context of energy infrastructure transitions. The results will help to (re)construct the specific structural and organizational designs based on the analyses of mobilization processes that are dependent on the actions of challenger actors. The cognitive approach allows us to put forward propositions not only on the conditions of action, but also on how relatively powerless actors are able to mobilize and (re)organize fields.

6 Conclusion

Project four integrates the results of projects one to three to draw conclusions about the transformation of the energy sector as a whole and to build up links to the theoretical problem of how novelty and change in meso-level social orders can be analyzed, a problem that — as Padgett/Powell 2012 have maintained — remains undertheorized in the social sciences.

Bearing in mind the overall objective of the study, the results of the individual projects will help to elaborate on and discuss different aspects and variations of sectoral change that reflect the influence of different developments. The findings will also indicate whether the accumulated changes might lead to the energy supply sector undergoing adjustment or even an entirely new design and foundation. The latter in particular will contribute to a broader understanding of the challenges linked to a potential transformation of the energy sector as a whole. In addition to an attempt to give a detailed analysis of change processes, questions will also be dealt with that are related to the driving forces of change as well as to the consequences of the analyses and the conditions for action and mobilization within the energy sector. Radical change or transformation initially consists of small steps. Whether these small steps ultimately create a bigger change depends on how far they succeed in altering both the field(s) to which they belong and the normal ways of doing things. While projects one to three analyze in detail specific problems linked to network extension, the energy-provider strategies, and decentralized solutions to energy supply, project four addresses more general topics and assessments.

Assuming that the *Energiewende* initiates a fundamental process of change, the Helmholtz-Association will enable a long term study of the recombining of elements and of a potentially new structural design to energy infrastructure. The individual projects provide detailed case knowledge on the micro-logics within different fields and enable us to learn more about the search to adapt organizational forms, patterns of interaction, structures, and regulations in a substantial modernization of the energy sector. Transformation in our understanding can also be interpreted as a kind of a tipping point that, from the first small innovative steps taken by multiple actors, might develop into a cascade. These innovative steps, that are based on efforts to organize, must reproduce in order to survive and make an impact. Stability on the other hand does not depend on behavioral constancy but rather on stable positions within the relevant field.

Our cases emphasize innovation in organizational forms and strategies. In the study's first phase we are not concerned with the formation or change of markets. We assume, however, that innovation in organizational forms will spill over into the reor-

ganization or creation of markets in which the innovation is embedded. The following two topics are addressed in the first phase of project four:

(a) Contours of a sector in transition

The most important general aim is to address the question of whether the energy sector is undergoing a transformation. In order to do this, the results of projects one to three are systematized and compared along a common set of analytic dimension (see Table two). This is intended to identify characteristics that go beyond the individual strategic actions fields, e.g. on whether a general trend towards a decentralization of the energy supply system can be found. We also discuss the extent and ease to which elements of the old system can be combined with elements of a transformed sector.

(b) Accelerating change

The reasons for a potential change of the energy system need more careful analysis. As mentioned in the state of the art section, the available literature presents a divergent set of analytical approaches and expectations. We will try to advance an explanatory model that focuses on power constellations, capabilities to organize and mobilize, and the ability to develop innovative measures. Taking projects one to three together, we attempt to find more general answers to the questions of how far political power constellations influence transition, the kind of influence constellations of social actors and organizations exert on the transition process, and the kind of conflicts and coordination deficits that may support or delay transition.

The attempt to reconstruct a potential transformation process, as well as the assessment of future developments, will enable us to find modes and variants which are involved in the development of new energy pathways. We know that these dependencies cannot change in a rapid and clear-cut manner, but rather in the form of a gradual replacement of organizational and institutional settings, essentially occurring by degrees as a long term accumulation of numerous transformation-related impulses (that we identify in the projects). This will then help us better understand the transformation of the energy sector.

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